CLAIMS

What is claimed is:

1. A sensor for a marine vessel comprising:

a housing that fits through a single opening in a hull of the vessel;

a removable body disposed in the housing;

a magnetized paddlewheel disposed in a first cavity formed on a first half of the body, the paddlewheel having a plurality of paddles extending from a circular central hub and rotatably mounted on an axle extending transverse a fore and aft direction of travel of the vessel;

a magnetic sensor located adjacent the paddles; and

a sonic transducer disposed in a second cavity formed on a second half side of the body.

2. The sensor of claim 1, wherein the cross-sectional area of the paddles in a plane transverse a direction of flow of water being traversed by the marine vessel and in a plane parallel the direction of flow versus the available cross sectional area in the respective planes defines a Cross-Sectional ratio in a range between about 0.25 and 0.5, and wherein the lowest point on the periphery of the hub is located tangentially adjacent to or vertically above a lowest point in the first cavity.

3. The sensor of claim 2, wherein the Cross-Sectional ratio in the plane parallel to the direction of flow is different than the Cross-Sectional ratio in the plane transverse the direction of flow.

4. The sensor of claim 2, wherein the Cross-Sectional ratio in the plane parallel to the direction of flow is about equal the Cross-Sectional ratio in the plane transverse the direction of flow.

5. The sensor of claim 1, wherein the paddles are symmetric in shape.

6. The sensor of claim 1, wherein the sonic transducer is a piezoelectric element having an aspect ratio defined in terms of the length, width, and height of the piezoelectric element, the aspect ratio being optimized such that the maximum acoustic energy of the element is produced when the element vibrates with a frequency of about 150 kHz to about 250 kHz.

7. The sensor of claim 6, wherein the maximum acoustic energy of the element is produced when the element vibrates with a frequency of about 235 kHz.

8. The sensor of claim 6, wherein the length is about 1.0 to 1.3 inches in length, about 0.1 to 0.5 inches in height, and about 0.1 to 0.5 inches in width.

9. The sensor of claim 8, wherein the length is about 1.25 inches, the height is about 0.23 inch, and the width is about 0.22 inch.

10. The sensor of claim 6, wherein the transducer has a beamwidth of about 11° x 38° at about -3dB.

11. The sensor of claim 6, wherein the piezoelectric element is made of PZT.

12. The sensor of claim 1, further comprising a thermal sensor for sensing water temperature disposed in a well formed in the body.

13. A sensor for a marine vessel comprising:

a housing that fits in a single circular opening through a hull of the vessel, the housing containing at least two sensors, a speed sensor and a depth sensor.

14. The sensor of claim 13, further including temperature sensor contained within the housing.

15. The sensor of claim 13, including a seal to prevent water from passing through the opening.

16. The sensor of claim 13, wherein the speed sensor is a paddlewheel type.

17. A transducer comprising:

a piezoelectric element having an aspect ratio defined in terms of the length, width, and height of the piezoelectric element, the aspect ratio being optimized such that the maximum acoustic energy of the element is produced when the element vibrates with a frequency of about 150 kHz to about 250 kHz.

18. The transducer of claim 17, wherein the maximum acoustic energy of the element is produced when the element vibrates with a frequency of about 235 kHz.

19. The transducer of claim 17, wherein the length is about 1.0 to 1.3 inches in length, about 0.1 to 0.5 inches in height, and about 0.1 to 0.5 inches in width.

20. The transducer of claim 19, wherein the length is about 1.25 inches, the height is about 0.23 inch, and the width is about 0.22 inch.

21. The transducer of claim 17, wherein the transducer has a beamwidth of about 11° x 38° at about -3dB.

22. The transducer of claim 17, wherein the piezoelectric element is made of PZT.

23. A method for installing a removable marine sensor in a marine vessel, comprising:

cutting a single hole in a hull of the marine vessel;

mounting a housing within the hole, the housing sealing the hole to prevent a liquid from entering the marine vessel; and

disposing a removable body in the housing, the body containing at least two sensors, a speed sensor and a depth sensor.

24. A sensor for a marine vessel comprising:

means for mounting a housing through a single opening in a hull of the vessel;

means for removing a body, containing a speed sensor and a depth sensor, disposed in the housing;

means for sensing a speed of the vessel; and

means for sensing a water depth.